DRAFT REPORT

IN-DELTA STORAGE PROGRAM EARTHWORK CONSTRUCTION COST ESTIMATE

Prepared for
Department of Water Resources
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URS

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1.1 BACKGROUND AND PURPOSE OF STUDY

The Department of Water Resources (DWR) is conducting feasibility-level engineering and environmental studies under the Integrated Storage Investigations Program. As part of the project evaluations, DWR is evaluating the technical feasibility and conducting engineering investigation for the In-Delta Storage Program. Engineering investigation will aim at developing solutions to enhance project reliability through improved embankment design and consolidation of inlet and outlet structures.

1.2 SCOPE OF WORK

As part of this feasibility study, the Department requests that URS Corporation (URS) carry out the following tasks: analyze suitable construction methods and estimate total project construction costs. The work will be conducted in accordance with all applicable standards and guidelines contained in Standard Agreement No. 4600001747 and in coordination with Department staff.

The work proposed below will include reviewing different applicable construction methods and evaluate the most feasible methods that are suitable for the proposed project, and prepare an estimate of the construction costs related to the proposed project. It is understood that the contractor will select its own method for construction.

The scope of work consists of the following tasks:

Task 1.1 – Collect and review existing information

Review all available information pertaining to the planned project, including existing reports, past studies, planned project configuration and design information.

Task 1.2 – Estimation of Quantities

Hydraulic and structural design information, design drawings, and quantity estimates for inlet/outlet structures, fish screens, pump stations and other related appurtenances as well as environmental mitigation work will be provided by DWR. Local island soil borrow material and earthwork volume estimates for all embankments are covered separately under Task Order No. IDS-1002-1747-006. Prepare additional quantity estimates for slope protection, piping protection and seepage control (pumping wells).

Task 1.3 – Construction Methods Analysis

Considering the subsurface conditions at the project islands, other constraints (physical, environmental, logistic, etc.), and quantity estimates, review applicable methods for constructing the various earthwork/embankment components and evaluate the most feasible method. Construction of fish screens, inlet/outlet structure, pumping stations and associated channels are covered in Task Order IDS-1102-1747-008. Provide details on task sequencing, including dewatering for borrow excavation, and construction of foundations.

Task 1.4 – Undertake Market Research and Establish Relevant Unit Costs for different construction materials and labor related to the project

Undertake market research, including quotations from contractors and suppliers, to obtain relevant unit costs for acquiring different construction materials (including compacted fill) and transporting to the project site, and the cost of labor and equipment required for placement of these materials, as applicable. Labor rates will be in prevailing wages. Costs related to land acquisition and permitting are not required.

Task 1.5 – Undertake Feasibility Cost Estimate for Earthwork

Based on the findings of Tasks 1.1 through 1.4, prepare a feasibility-level cost estimate for constructing the earthwork components for the proposed project, including excavation, dewatering for borrow areas, preparation and placement of fill materials, embankment, riprap, and seepage control. Prepare feasibility-level cost spreadsheets including information on the extent of labor, materials and equipment required for overall construction. In addition, estimate contactor's general and administrative costs, general requirements, and profit and bond mark-ups to be applied to the direct construction cost. Cost estimate will include allowances (in percentage of overall construction cost) for contingencies, engineering and design, and construction contract administration and management. Cost estimates for fish screens, inlet/outlet structure, pumping stations and associated channels are covered in Task Order IDS-1102-1747-008.

2.1 EXISTING CONDITIONS

Webb Tract and Bacon Islands are located in the Sacramento – San Joaquin River Delta, near Stockton, California, as shown on Figure 1. Webb Tract is located in the northeast corner of Contra Costa County near Oakley, California. Bacon Island is located within San Joaquin County, approximately 4 miles south of Webb Tract.

The Sacramento-San Joaquin River Delta was developed for agricultural purposes from a tidal marsh in the 1800s. As part of the development, levees were constructed on the underlying peat and soft clay to form islands. The existing channels were improved, and new channels were dredged.

Webb Tract and Bacon Island encompass about 5,500 acres and 5,600 acres, respectively. The combined length of levees on both islands is about 27 miles. The ground elevation of both Webb Tract and Bacon Island, initially, was near sea level. Land subsidence, primarily as a result of the loss of organic material and peat, has steadily decreased the surface elevation. The loss of organic material is caused by exposure of peat to oxygen (oxidation), wind erosion, burning as well as some other factors. The existing ground surface elevation on most of Webb Tract and Bacon Island ranges from about –10 feet to lower than –15 feet below mean sea level.

The interiors of both islands consist of agricultural areas and irrigation ponds. The agricultural areas are linked by unpaved embankment roads. Ditches were excavated throughout the islands as part of the irrigation and drainage systems. The sites are mostly covered with plowed soil for future crop growing or dried crops left from the previous harvest. Areas with no agricultural use are covered with grass and shrubs. Many parts of the islands are marshy, especially on Webb Tract.

2.2 PROPOSED RESERVOIRS

The proposed reservoirs on the islands will be developed by constructing embankments against the existing levees to crest elevation +10. The plan views of Webb Tract and Bacon Island showing the potential borrow area limits are presented on Figures 2 and 3, respectively. The typical conceptual embankment sections are shown on Figure 4. The two options shown on Figure 4 that were considered for construction cost estimation are the Rock Berm Option and Bench Option. The Rock Berm Option consists of placing rockfill on the slough-side of the levee to provide for stability (URS, 2003a). For the Bench Option, a bench would be excavated at elevation +3.0 to provide for stability. As shown on Figures 2 and 3, the Rock Berm Option includes 3,000 lineal feet of embankments on each island that are configured as the Bench Option to reduce the size of slough-side rockfill sections. Riprap and riprap bedding would be placed on the upper portion of the slough-side slopes to protect the embankment slopes from wave erosion as shown on Figure 4.

Both options include embankment fill on the reservoir side that would be obtained from excavations in borrow areas within the islands as shown on Figures 2 and 3. The reservoir-side slopes would be 3H:1V from the crest to elevation +4.0 (the maximum reservoir elevation), and the slope would be 10H:1V below elevation +4.0. Riprap underlain by riprap bedding would be placed from the crest to elevation +3.0 to protect the steeper part of the slope from wave erosion.

Riprap would also be placed on the north and west facing 10:1 slopes, which are the general prevailing wind and storm wind directions.

A heavy-duty woven filter fabric would be located between the existing levee and new embankment fill to mitigate piping potential as indicated in the Embankment Design Analysis report (URS, 2003a). In addition, woven filter fabric would be placed on the 10:1 slopes. Where not covered by riprap, the filter fabric would be covered by a 2-foot thick layer of compacted sandy fill. This fill would require continual periodic maintenance to repair erosion.

Both options have a seepage control system consisting of interceptor wells along the crest of the embankments as shown on Figure 4. The wells would have an average depth of 50 feet and a spacing of about 200 feet, and would be used to pump water from the sandy soils beneath the peat.

3.1 BASIS OF QUANTITY ESTIMATES

The plan views of Webb Tract and Bacon Island shown on Figures 2 and 3, respectively, and the typical embankment sections for the Rock Berm and Bench options shown on Figure 4, are the basis for quantity and cost estimation. The following assumptions were used to estimate earthwork quantities:

- Excavation
  - No excavation assumed for Rock Berm option
  - Excavate existing levee to elevation +3.0 feet for Bench Option
  - Bench width varies with base of peat elevation to maintain adequate stability
- Embankment Fill
  - Volume based on average sections developed for stability analysis
  - Volume varies with base of peat elevations
- Reservoir-side Filter Fabric, Riprap Bedding and Riprap
  - Riprap bedding thickness of 1.0 foot above elevation +3.0 and filter fabric below this elevation
  - Riprap thickness of 2.5 feet above elevation +3.0 and 1.75 feet thick below this elevation (on the north and west facing slopes)
  - Earthfill placed on top of filter fabric on south and east facing slopes
  - Filter fabric placed on the reservoir-side of the existing levee embankments for mitigation of piping potential (see Section 2.2). The filter fabric extends from the crest to 30 feet along the ground surface as shown on Figure 4.
- Slough-side Rockfill, Riprap Bedding and Riprap
  - Rock Berm Option
    1. Based on conversations with Delta Wetlands and field observations, the rockfill volumes are based on an assumed average thickness of 2 feet of existing rockfill on the slough-side slopes of the levees for Webb Tract and Bacon Island, extending to elevation –2 feet (1 foot below low tide).
    2. Rock berm slopes were based on stability, which depends on bottom of peat elevation, slough slope, and slough bottom elevation
    3. From crest of new embankment to crest of existing embankment:

       Riprap bedding thickness of 1.0 foot

       Riprap thickness of 2.0 feet
  - Bench Option
    1. Riprap bedding thickness of 1.0 foot

2. Riprap thickness of 2.0 feet (except 16,000 feet adjacent to Frank's Tract and Mildred Island, which is 2.5 feet)

3. Riprap extends from crest to elevation, +3.0 feet

- Seepage Control System
  - Interceptor well depth of 50 feet and spacing of 200 feet, with 20% additional wells
  - No interceptor wells adjacent to Frank's Tract, Mildred Island, along the San Joaquin deep ship channel (see Figures 2 and 3 for locations of wells)

3.2 ESTIMATED QUANTITIES

The estimated excavation and in-place embankment quantities for the Webb Tract Rock Berm and Bench options are presented in Tables 3-1 and 3-2, respectively. The estimated excavation and in-place embankment quantities for the Bacon Island Rock Berm and Bench options are presented in Tables 3-3 and 3-4, respectively.

Table 3-1
Quantity Estimate for Webb Tract (Rock Berm Option)

Item	**Units**	**Estimated Quantity**
Excavation	CY	0
Embankment Fill	CY	4,600,000
Reservoir Riprap Bedding	CY	74,000
Reservoir Riprap above el. +3	CY	185,000
Reservoir Riprap on 10:1 slope	CY	300,000
Slough Riprap Bedding	CY	7,500
Slough Riprap	CY	15,000
Slough Rockfill	CY	405,000[1]

[1]Includes a 20% increase due to loss from under-water placement.

Table 3-2
Quantity Estimate for Webb Tract (Bench Option)

Item	Units	Estimated Quantity
Excavation	CY	500,000
Embankment Fill	CY	10,000,000
Reservoir Riprap Bedding	CY	74,000
Reservoir Riprap above el. +3	CY	185,000
Reservoir Riprap on 10:1 slope	CY	300,000
Slough Riprap Bedding	CY	55,000
Slough Riprap	CY	110,000
Slough Rockfill	CY	0

Table 3-3
Quantity Estimate for Bacon Island (Rock Berm Option)

Item	Units	Estimated Quantity
Excavation	CY	0
Embankment Fill	CY	5,100,000
Reservoir Riprap Bedding	CY	80,000
Reservoir Riprap above el. +3	CY	200,000
Reservoir Riprap on 10:1 slope	CY	284,000
Slough Riprap Bedding	CY	8,500
Slough Riprap	CY	17,000
Slough Rockfill	CY	240,000[1]

[1]Includes a 20% increase due to loss from under-water placement.

Table 3-4
Quantity Estimate for Bacon Island (Bench Option)

Item	Units	Estimated Quantity
Excavation	CY	480,000
Embankment Fill	CY	10,100,000
Reservoir Riprap Bedding	CY	80,000
Reservoir Riprap above el. +3	CY	200,000
Reservoir Riprap on 10:1 slope	CY	284,000
Slough Riprap Bedding	CY	65,000
Slough Riprap	CY	130,000
Slough Rockfill	CY	0

4.1 MATERIALS

Riprap bedding, riprap, and slough-side rockfill materials will need to be imported from commercial sources. For cost estimating purposes, the preliminary gradations shown below were developed to obtain material costs. The riprap bedding gradation was based on USBR (1987) filter criteria to prevent the sandy embankment soils from washing out through the riprap. Riprap sizing was based on wave height estimates (Flooding Analysis, URS, 2003b).

RIPRAP BEDDING

Particle Size	Percent Passing
3-inch	100
1-inch	70 – 85
No. 4 sieve	40 – 60
No. 200 sieve	5

RIPRAP 1

Particle Weight (lbs)	Percent Passing
1,500	100
250	40 – 60
5	15 – 25
1	0 – 5

RIPRAP 2

Particle Weight (lbs)	Percent Passing
750	100
125	40 – 60
5	15 – 25
1	0 – 5

SLOUGH-SIDE ROCKFILL (CALTRANS ¼ TON)

Particle Weight (lbs)	Percent Passing
1,000 (450 kg)	95 – 100
500 (220 kg)	0 – 50
75 (34 kg)	0 – 5

4.2 POTENTIAL AGGREGATE SOURCES

A survey of commercial sources was conducted to obtain prices for the materials discussed in Section 4.1 for use in cost estimation. The results of the survey are included in Appendix A. Shown below is a list of six commercial gravel and rock suppliers that were contacted. However, only Dutra Materials and Syar Industries quoted prices.

Dutra Materials, Inc.
1000 Point San Pedro Road
San Rafael, CA
415-258-6876
415-258-9714 (fax)
Contact: Harry Stewart

Syar Industries, Inc. Madison Sand & Gravel
2301 Napa-Vallejo Highway
P.O. Box 2540
Napa, CA
707-259-5839
707-254-3018 (fax)
Contact: Scott Thomas

RMC Pacific Materials
515 Mitchell Canyon Road
Clayton, CA
925-426-2130
925-426-2112 (fax)
Contact: Josh Hinchey

Sevens Creek Quarry, Inc.
12100 Stevens Canyon Road
Cupertino, CA
408-253-2512
408-253-7621 (fax)
Contact: Pat Hennigar

Hanson Aggregates Mid-Pacific, Inc.
P.O. Box 580
Pleasanton, CA
925-426-4033

DSS Company Vernalis Plant
2648 W. Blewett Road
Tracy, CA
209-830-5130
209-830-5133 (fax)
Contact: Julie Jimenez

5.1 GENERAL

The engineer's construction cost estimate prepared is intended to be used for budgetary requirements and economic analysis. The estimate was prepared in accordance with a Class 4 engineer's construction cost estimate as defined by Association for the Advancement of Cost Engineering International (AACE, 1997). The typical expected accuracy range for this class estimate is –15% to –30% on the low side and +20% to +50% on the high side.

The cost estimates have been prepared from the information available at the time of the estimate. The final construction costs will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. The construction cost estimates do not include costs for land and environmental permitting and mitigation. An experienced construction cost estimator with construction and hard-dollar contract bid experience prepared this cost estimate.

Construction pricing for the project is in March 2003 U.S. dollars and is based on the quantity estimates discussed in Section 4. Pricing is accomplished with unit pricing from published and internally developed and maintained historical databases and from crew make-up for the earthwork. All unit pricing is factored for location, contractor markups and other project specific criteria. Material pricing, where necessary, was obtained from vendor quotations as discussed in Section 4, current cost estimates, and cost estimator experience. Crews and equipment spreads were developed for the major earthwork activities. Logic, methods and procedures for developing costs are typical for the construction industry.

5.2 COST ESTIMATE ASSUMPTIONS

The assumptions used in the construction cost estimates are as follows:

- Costs for project management, administration and quality control staffing are based on usual wages and salaries for the area.
- Prevailing wage rates were used to estimate labor costs.
- General and administrative (G&A) cost is 5% of the direct cost; profit is 10% of the direct cost plus G&A cost; and bond is 1% of the direct cost plus G&A cost plus profit.
- Costs have not been included for maintaining and operating the existing dewatered condition of the interior of the islands during construction.
- A barge dock unloading facility will be constructed for unloading riprap bedding, riprap, and rockfill materials.
- A 20% yield factor was used to estimate the required borrow excavation volume to provide the required in-place embankment fill volumes indicated in Section 4.
- Overburden excavation volumes were estimated based on the borrow area exploration work at Webb Tract and Bacon Island (URS, 2003c). For Bacon Island, the overburden volume was estimated at 3.6 times the required borrow excavation volume. For Webb Tract, the borrow excavation was assumed to be in the western part of the island where the overburden is the thinnest, and the overburden volume was estimated at 1.3 times the required borrow

excavation volume. Costs developed for removal of overburden assume that excavated overburden is wasted in adjacent borrow pits where excavation has been completed.

- Pricing for riprap bedding, riprap, and rockfill is from local commercial material suppliers with allowance for delivery to the islands by barge.
- Rockfill for the Rock Berm option will be placed underwater; due to underwater placement, a loss factor of 20% was assumed.
- It is understood that earthwork construction to buttress Delta levees has not required dewatering of the borrow area excavations (Hultgren-Tillis, 2002 and 2003). Based on this experience, costs for groundwater dewatering systems (e.g., well-points) for excavation in the borrow areas were not included. However, pumping from the existing groundwater control system would continue throughout construction. Construction costs presented in this report allow for drainage ditch and sump excavation and sump pumping.
- A 5-year embankment construction period was assumed due to the weak peat soil foundation (Embankment Design Analysis, URS, 2003a).
- A contingency allowance has not been included. DWR will include a contingency allowance in the project cost estimates.

5.3 CONSTRUCTION APPROACH AND SCHEDULE

The construction approach that follows is the engineer's general assessment of how the construction could proceed. However, each contractor would have its own approach to optimize construction and minimize costs.

A construction schedule for the Rock Berm Option was prepared, as this option was found to be significantly less costly than the Bench Option (see Section 5.4). The construction schedule for the embankments is shown within the overall project construction schedule in Appendix C. The schedule shows a 6-year total construction duration (5 years for embankment construction plus one year for the seepage control system), working about 8 months per year (between April and November). The contractor would need to keep a work force on site to monitor, maintain and repair the earthworks during the winter months.

The schedule shows the basic sequence of construction activities and that work on both islands would proceed concurrently. Earthwork construction could proceed under one large contract or could be executed under three separate contracts: one each for Webb Tract embankments, Bacon Island embankments, and the seepage control system. The schedule also indicates the engineering and bidding periods. The main construction activities are discussed below.

- Mobilization: Mobilization includes securing required permits, transporting equipment to the site, and setting up temporary facilities (offices, storage areas, water supply, power, etc.).
- Clearing, Grubbing and Site Preparation: This activity will include clearing and grubbing the site, stripping the peat, and excavating drainage ditches and sumps in borrow area paddock areas. The peat will be stockpiled near the paddock excavations and replaced in the paddocks as the borrow materials become exhausted. The peat could be excavated by large excavators (equipped with wide, low contact pressure tracks) or drag-lines. The stability of the borrow excavation slopes with adjacent heavy equipment would need to be evaluated.

- Borrow Area Excavation and Embankment Fill Construction: Constructing haul roads, the barge dock unloading facility, and other temporary construction are included in this activity. Haul roads would require ongoing grading, maintenance, and dust control. Excavation of borrow materials would be accomplished by large excavators and hauled by trucks along haul roads to stockpiles. Moisture conditioning to dry out the materials would be done in the stockpiles by disking and aerating the materials prior to hauling the materials to the embankments by scrapers or trucks. Bulldozers would spread the materials and rollers would compact the materials in lifts. The maximum fill differential elevation would need to be limited to reduce the potential for foundation failure during construction. Therefore, the fill would need to be placed in horizontal lifts around the entire island perimeter prior to beginning another lift. For embankment construction to be completed in 5 years, approximately 1.9 million cubic yards of earthfill per year would need to be placed in the embankments, on average, in both reservoir islands combined (about 5,400 cubic yards per day per island). For estimating purposes, earthfill operations would generally take place 5 days per week, 8 hours per day.
- Rockfill on Slough side: Placement of rockfill would be accomplished by placing rock with cranes from barges.
- Riprap and Bedding: Riprap and bedding on the reservoir and slough sides would be placed by excavators, lagging behind the embankment fill placement. Bulldozers would also be used to spread the riprap and bedding materials.
- Placement of Filter Fabric: Woven filter fabric would be placed on the reservoir side of the existing levees during the first two years of embankment placement to serve for erosion and piping control during construction (see Section 2.2). Filter fabric would also be placed on the 10:1 slopes of the new fill.
- Road Base: The road base would be placed on the embankment crests after they have been topped out.
- Instrumentation: Vibrating wire piezometers and survey points would be installed at selected locations as the embankments are placed to monitor embankment performance during construction. Inclinometers and final survey points would be installed at the completion of embankment construction. Due to the length of the reservoir island embankments (total of 27 miles) and the need for a comprehensive monitoring program, an automated data acquisition system (ADAS) is included.
- Seepage Control System: Well drilling would begin after the embankments have been completed. This work would occur during the sixth year of construction to allow for some settlement prior to well installation; this would reduce the potential for damage to the wells.

5.4 CONSTRUCTION COST ESTIMATES

The construction cost estimates are summarized in Table 5-1 for the Rock Berm option and in Table 5-2 for the Bench option. Development of the construction costs estimates for the embankments is included in Appendix B. Appendix C, which was prepared by DWR, includes cost estimate details and construction methodology for the earthworks required at the integrated facilities. Appendix C also includes an overall project construction schedule for the island embankments, integrated facility earthworks and integrated facility structures. The costs for the integrated facility earthworks are summarized in Section 6. Cost estimates for the integrated facility structures are presented in a separate report by CH2M Hill.

Tables 5-1 and 5-2 show subtotals without contingency allowances; contingencies will be included by DWR in their cost estimate presentations. The contingency pertains to unlisted items and for quantity changes that normally result during succeeding phases of design development. As such, this is a "design contingency", and does not address change orders and other construction growth items that occur during construction. The most significant risk items are in the earthfill costs, specifically management of groundwater and overburden stripping.

As shown in Tables 5-1 and 5-2, the Rock Berm Option was found to cost significantly less than the Bench Option.

IDS PROJECT
CONSTRUCTION COST ESTIMATE
TABLE 5-1. ROCK BERM OPTION

Item	Total Quantity	Units	Unit Price	Amount	Comments
1. ISLAND EMBANKMENTS					
Webb Tract					
Clear and Grub	280	Acres	1,722.00	482,160	
Rockfill	405,000	CY	70.00	28,350,000	
Embankment Fill	4,600,000	CY	7.90	36,340,000	
Filter Fabric (btwn levee & new emb)	7,400,000	SF	0.22	1,628,000	added 25% for overlaps
Filter Fabric - Reservoir Side (10:1)	9,760,000	SF	0.22	2,147,200	added 10% for overlaps
Riprap - Slough Side	15,000	CY	52.60	789,000	2.0 feet thick (2.5 feet thick adjacent to Franks Tract)
Bedding - Slough Side	7,500	CY	49.10	368,250	1.0 feet thick
Riprap - Reservoir Side	185,000	CY	47.40	8,769,000	2.5 feet thick
Bedding - Reservoir Side	74,000	CY	43.90	3,248,600	1.0 feet thick
Riprap - 10:1 Reservoir Slope	300,000	CY	47.40	14,220,000	north and west facing slopes only; 1.75 feet thick (avg.)
Road base (20' x 6")	25,000	CY	34.30	857,500	
Subtotal				**97,199,710**	
Bacon Island					
Clear and Grub	210	Acres	1,722.00	361,620	
Rockfill	240,000	CY	77.20	18,528,000	
Embankment Fill	5,100,000	CY	9.30	47,430,000	
Filter Fabric (btwn levee & new emb)	8,600,000	SF	0.22	1,892,000	added 25% for overlaps
Filter Fabric - Reservoir Side (10:1)	10,820,000	SF	0.22	2,380,400	added 10% for overlaps
Riprap - Slough Side	17,000	CY	52.60	894,200	2.0 feet thick (2.5 feet thick adjacent to Mildred Island)
Bedding - Slough Side	8,500	CY	49.10	417,350	1.0 feet thick
Riprap - Reservoir Side	200,000	CY	47.40	9,480,000	2.5 feet thick
Bedding - Reservoir Side	80,000	CY	43.90	3,512,000	1.0 feet thick
Riprap - 10:1 Reservoir Slope	284,000	CY	47.40	13,461,600	north and west facing slopes only; 1.75 feet thick (avg.)
Road base (20' x 6")	28,000	CY	34.30	960,400	
Subtotal				**99,317,570**	
2. SEEPAGE CONTROL SYSTEM					
Interceptor Wells	480	EA	19,044.00	9,141,120	assume 1 per 200 l.f. emb.; 40 gpm each
Monitoring Wells	100	EA	5,490.00	549,000	
Electrical and Control Systems	480	EA	5,229.00	2,509,920	
Subtotal				**12,200,040**	
3. INSTRUMENTATION	1	LS	3,000,000.00	**3,000,000**	
SUBTOTAL				**211,717,320**	
MOBILIZATION	1	LS	14,986,000.00	**14,986,000**	
SUBTOTAL (without contingency)				**226,703,320**	
Say				**227,000,000**	

Notes:
Embankment fill includes haul roads, remove overburden, excavate and moisture condition borrow, load, haul, and compact fill.

Imported rockfill cost includes cost for barge unloading dock facility:
Webb: $ 59.61 + 10.43 = 70.04 say $70.00 (4,223,500 / 405,000 = $10.43)
Bacon: $ 59.61 + 17.60 = 77.21 say $77.20 (4,223,500 / 240,000 = $17.60)

IDS PROJECT
CONSTRUCTION COST ESTIMATE
TABLE 5-2. BENCH OPTION

Item	Total Quantity	Units	Unit Price	Amount	Comments
1. ISLAND EMBANKMENTS					
Webb Tract					
Clear and Grub	280	Acres	1,722.00	482,160	
Excavation	500,000	CY	3.90	1,950,000	
Embankment Fill	10,000,000	CY	7.90	79,000,000	
Filter Fabric (btwn levee and new emb)	7,400,000	SF	.22	1,628,000	added 25% for overlaps
Filter Fabric - Reservoir Side (10:1)	9,760,000	SF	.22	2,147,200	added 10% for overlaps
Riprap - Slough side	110,000	CY	58.20	6,402,000	2.0 feet thick (2.5 feet thick adjacent to Franks Tract)
Bedding - Slough Side	55,000	CY	54.70	3,008,500	1.0 feet thick
Riprap - Reservoir Side	185,000	CY	53.00	9,805,000	2.5 feet thick
Bedding - Reservoir Side	74,000	CY	49.50	3,663,000	1.0 feet thick
Riprap - 10:1 Reservoir Slope	300,000	CY	53.00	15,900,000	north and west facing slopes only; 1.75 feet thick (avg.)
Road base (20' x 6")	25,000	CY	39.90	997,500	
Subtotal				**124,983,360**	
Bacon Island					
Clear and Grub	310	Acres	1,722.00	533,820	
Excavation	480,000	CY	3.90	1,872,000	
Embankment Fill	10,100,000	CY	9.35	94,435,000	
Filter Fabric (btwn levee and new emb)	8,600,000	SF	.22	1,892,000	added 25% for overlaps
Filter Fabric - Reservoir Side (10:1)	10,820,000	SF	.22	2,380,400	added 10% for overlaps
Riprap - Slough side	130,000	CY	58.00	7,540,000	2.0 feet thick (2.5 feet thick adjacent to Mildred Island)
Bedding - Slough Side	65,000	CY	54.50	3,542,500	1.0 feet thick
Riprap - Reservoir Side	200,000	CY	52.70	10,540,000	2.5 feet thick
Bedding - Reservoir Side	80,000	CY	49.20	3,936,000	1.0 feet thick
Riprap - 10:1 Reservoir Slope	284,000	CY	52.70	14,966,800	north and west facing slopes only; 1.75 feet thick (avg.)
Road base (20' x 6")	28,000	CY	39.60	1,108,800	
Subtotal				**142,747,320**	
2. SEEPAGE CONTROL SYSTEM					
Interceptor Wells	480	EA	19,044.00	9,141,120	assume 1 per 200 l.f. emb.; 40 gpm each
Monitoring Wells	100	EA	5,490.00	549,000	
Electrical and Control Systems	480	EA	5,229.00	2,509,920	
Subtotal				**12,200,040**	
3. INSTRUMENTATION	1	LS	3,000,000.00	**3,000,000**	
SUBTOTAL				**282,930,720**	
MOBILIZATION	1	LS	14,986,000.00	**14,986,000**	
SUBTOTAL (without contingency)				**297,916,720**	
Say				**298,000,000**	

Notes:
Embankment fill includes haul roads, remove overburden, excavate and moisture condition borrow, load, haul, and compact fill.

Imported riprap, bedding, and road base costs include cost for barge unloading dock facility:
Webb: add $5.63 per CY to unit cost from Appendix B (4,223,500 / 749,000 = $5.63)
Bacon: add $5.36 per CY to unit cost from Appendix B (4,223,500 / 787,000 = $5.36)

This report presents URS' estimated construction costs for earthwork for the reservoirs at Webb Tract and Bacon Island. The engineer's construction cost estimate prepared is intended to be used for budgetary requirements and economic analysis. Construction cost estimates for fish screens, inlet/outlet structure, pumping stations and associated channels are covered separately.

Cost estimates were developed for two reservoir options: Rock Berm Option and Bench Option. The Rock Berm Option consists of placing rockfill on the slough-side of the levee to provide for stability. For the Bench Option, a bench would be excavated at elevation +3.0 to provide for stability. Earthwork quantities were estimated and a survey of commercial sources was conducted to obtain prices for riprap, riprap bedding and rockfill materials for use in cost estimation. Crews and equipment spreads were developed for major earthwork activities.

The estimated subtotal construction costs, without contingencies, for the two reservoir embankment options, and the integrated facility earthworks, are summarized in Table 6-1 below.

Table 6-1. Summary of Estimated Construction Costs

Option	Embankments [a]	Earthworks for Integrated Facilities [b]	Total
Rock Berm	$227 million	$71.2 million	$298 million
Bench	$296 million	$71.2 million	$367 million

[a] See Tables 5-1 and 5-2, and Appendix B.
[b] See Appendix C.

The Rock Berm Option was found to cost about $69 million (excluding contingency) less than the Bench Option. DWR will need to include contingencies as discussed in Section 5.4. Cost allowances will need to be included for engineering, legal, lands and right-of-way, permits, environmental mitigation, administration, and escalation. Reestablishing the embankment crest following completion of construction, erosion repair, interceptor well and pump maintenance, and other operation and maintenance costs have not been evaluated as part of these capital construction cost estimates.

The construction approach was discussed and the construction schedule was developed for the Rock Berm Option. It is estimated that 6 years would be required to construct the reservoir islands (embankments and seepage control systems).

It is understood that earthwork construction to buttress Delta levees has not required dewatering of the borrow area excavations. Based on this experience, costs for well-point dewatering systems for excavation in the borrow areas were not included. However, pumping from the existing groundwater control system would continue throughout construction. Further design development should include field test excavations in the borrow areas at both Webb Tract and Bacon Island to confirm that dewatering systems are or are not needed for borrow excavations. This field test work should also include assessments of effort required to dry out the borrow materials sufficiently for use in embankment construction. The results of the field test work would be used to improve the reliability of the cost estimates. The costs associated with maintaining and operating the existing groundwater control system during construction should also be assessed and included the cost estimates.

Overburden excavation has a significant effect on construction costs, especially for Bacon Island. Further field investigations of the borrow areas are recommended to better define the available material quantities and characteristics, and to confirm the required overburden excavation at the islands. These field tests would also be used to assess whether borrow excavations should be extended below the 15-foot limit used in the cost estimates for this study. Deeper excavations could be more efficient considering the amount of required overburden excavation, although groundwater issues would increase.

Further investigations should include a survey of the slough-sides of the levees to confirm the amount and extent of existing rockfill. This information would be used to evaluate where additional rockfill would be required.

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